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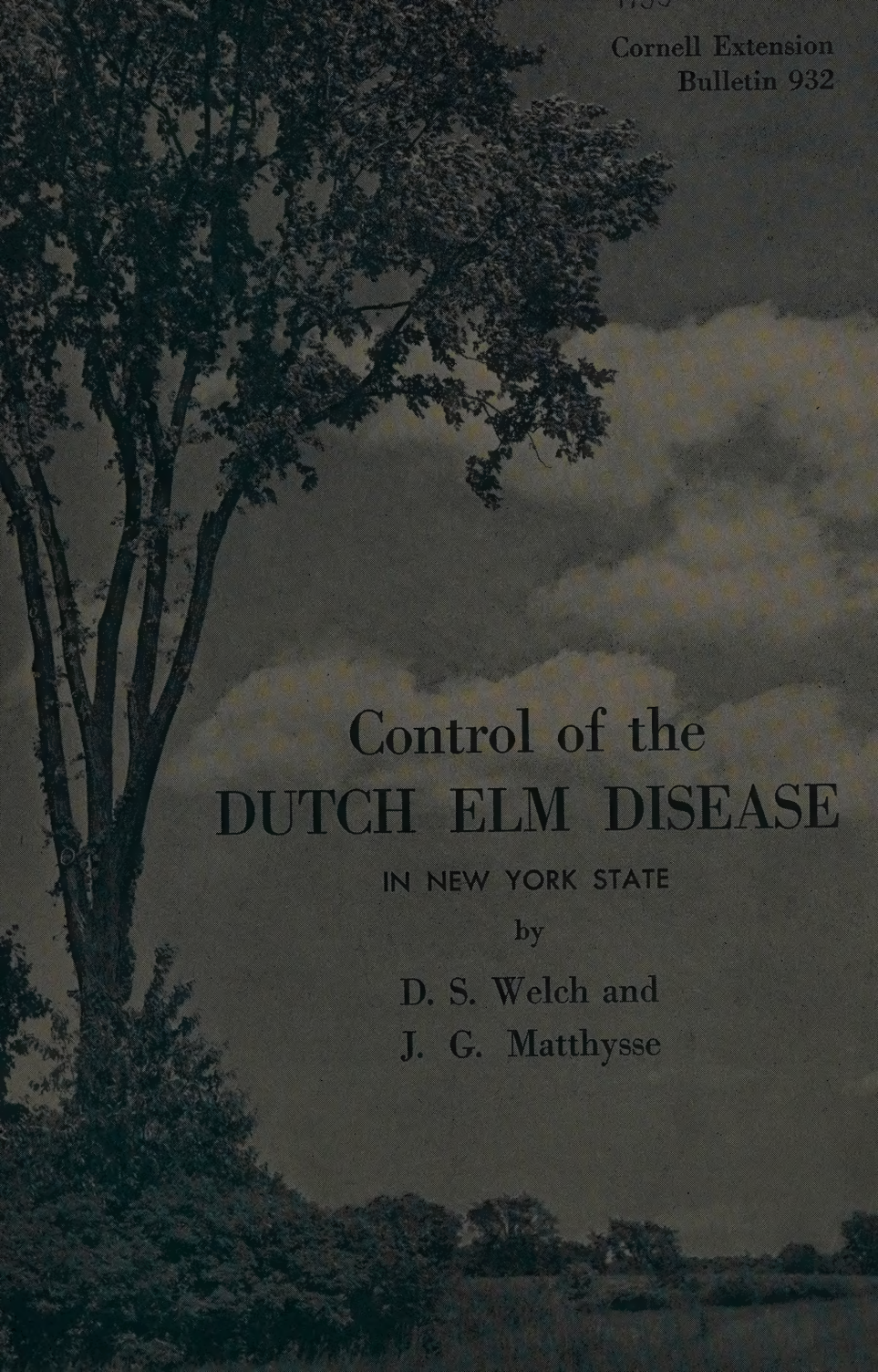

Control of the DUTCH ELM DISEASE

IN NEW YORK STATE

by

D. S. Welch and
J. G. Matthysse

In Brief

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The Dutch elm disease is caused by a fungus that gets into the water-conducting vessels of the tree 3

Insects that spread the disease

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The relation between the elm bark beetles and the spread of the disease furnishes the key to the control methods recommended. It is imperative to prevent the development of large numbers of beetles. Every effort should be made to eliminate or destroy all potential beetle-breeeding materials before the *first of April each year*. Dormant applications of insecticides may be used to supplement the destruction of beetle-breeding elm wood. Since these sprays are expensive and difficult to apply at the proper time, their use is limited to critical situations ..... 10 to 14

General care of elms

Frequent and careful pruning of elms to remove all dead and weak or injured branches is a desirable practice. Spraying for general insects and diseases protects elms from troubles that tend to weaken them and to cause branches to die or whole trees to weaken and die. Some elms need fertilizers, too. These must be applied so that they reach the feeding roots of the tree. In construction of sidewalks and buildings, tree roots are sometimes severed or mutilated. Such trees need additional water, especially in periods of severe drought. To be effective, watering must wet the soil to a depth of several feet. Leaking gas mains sometimes cause injury to, and the death of, elm trees. A carefully planned program of feeding, pruning, and watering may save trees if the gas injury is detected before it has gone too far ..... 12 to 16

Control of the DUTCH ELM DISEASE in New York State

D. S. WELCH AND J. G. MATTHYSSE

THE Dutch elm disease is a relatively new disease of American elms. The results are fatal, since infected trees seldom recover and death takes place within a few years. Where the disease has been allowed to go unchecked, it is capable of wiping out whole groups of plantings of elm. Since its discovery in New York State in 1933, the disease has gradually spread throughout the State so that now it may appear in any locality where there are elms. Where the American elm is prized for shade and ornament, it is imperative to control the disease before it becomes well established.

The control of the Dutch elm disease is a unique and baffling problem. It is the first fatal disease of an important shade tree to be recognized in epidemic form in this country and does not lend itself to control by the conventional methods. The spread and the intensification of the disease in a locality are influenced by conditions which often are beyond the control of an individual, with the result that public and private interests and values are inescapably involved.

Certain fundamental facts regarding this disease and ways to help to control its spread in residential areas or wherever the elm is valued in the landscape are discussed on the following pages.

Cause

THE Dutch elm disease is caused by a fungus (*Ceratostomella ulmi* (Schwarz) Buisman), that gets into the water-conducting vessels of the tree and multiplies rapidly there, causing the leaves to wilt and the tree to die. It is introduced into healthy elms by elm bark beetles feeding on twigs and on small branches.

Insects That Spread the Disease

IN THE United States two species of elm bark beetles carry the Dutch-elm-disease fungus to healthy trees. They are the smaller European elm bark beetle (*Scolytus multistriatus* Marsh) and the native American elm bark beetle (*Hylurgopinus rufipes* Eichh). Both insects are well established in New York State. To help to understand their relation to the Dutch elm disease, their life histories are given.

FIGURE 1. THE SMALLER EUROPEAN ELM BARK BEETLE (A) AND LARVAE (B)
Much enlarged

The European elm bark beetle

There are two broods of the European elm bark beetle each year, a spring and a summer brood. Since the spring brood is the one that is the immediate cause for the destructiveness of the Dutch elm disease, control measures are largely concerned with this brood. The spring brood passes the winter in the form of partially developed larvae or grubs (figure 1, B) between the bark and the wood of elm that was cut or broken, or that died the previous summer. In early spring, the beetles complete their development and emerge in the form of winged adults (figure 1, A) through small holes in the bark. The emergence of these adult beetles begins shortly after May 1 and continues daily over a period of a few weeks.

These beetles feed on twigs of living trees close to the wood from which they emerge (figures 2 and 3). If very few or no elm trees are near-by or if there are large numbers of beetles, they fly farther to feed. Individual trees run the chance of infection in proportion to the number of beetles that feed on them. Usually, a small amount of dead wood or a small number of beetles endanger elms within 100 or 200 feet of the source. The chances of infection are greatest within 100 feet from the wood source and diminish rapidly up to 300 feet. Seldom are there infections as far as 300 to 500 feet, and rarely more than 500 feet, from the source.

After feeding, the beetles seek wood suitable for breeding. Frequently they do not find such wood near

FIGURE 2. THE WOODPILE, A BREEDING PLACE OF THE BARK BEETLE
Beetles emerging from the elm wood in the woodpile probably inoculated the elm tree near-by

A B

FIGURE 3. DAMAGE TO SAPWOOD BY THE SMALLER EUROPEAN ELM BARK BEETLE
A, Feeding scars made by beetles in crotches of healthy elm twig; B, sapwood of healthy tree with bark removed to show marks made by beetles in an attempt to establish colonies

their place of emergence and must move greater distances. This accounts for the long-distance spread of the fungus into new previously uninvaded areas adjacent to areas where the disease is already present. It is during May and June that the adults from the spring brood seek and enter dead or dying elm wood suitable for egg-laying purposes. Such wood must be of the proper moisture content. Elms dying from the Dutch elm disease are particularly attractive to the beetles at this time. Such trees usually become heavily infested, thereby greatly increasing the bark-beetle population in the area where the disease is present. The fungus is carried into the egg-laying channels cut in dead wood by the female beetle and it thrives in the channels made by the developing larvae (figure 4).

FIGURE 4. ENGRAVING ON SAPWOOD MADE BY THE BEETLE AND ITS LARVAE

The summer brood begins to mature in late July, and flights of adults from this brood may continue in August and into September. There is no evidence to date that these summer-brood adults, which carry the fungus with them in flight, inoculate healthy elms, for few elms are believed to be in a susceptible stage at this season. The summer brood of beetles may, however, be of considerable importance in increasing the number of beetles the following spring, provided there is suitable wood near-by in which to lay their eggs. It is their larvae that produce the dangerous spring brood of beetles.

The native elm bark beetle

The native elm bark beetle is also of importance as a carrier of Dutch elm disease and in some areas of central and northern New York it is the only carrier beetle now present. The life cycle is more complicated than that of the lesser European elm bark beetle. There is one and a partial second generation each year. Winter is spent both as larvae and as adults. The wintering larvae superficially resemble those of the lesser European elm bark beetle. These larvae, however, mature slowly, finally emerging as beetles in late June and July. The beetles then feed in short tunnels which they make in the bark of branches and limbs of living elms. They do not feed in the small twig crotches as do the lesser European elm bark beetles. These native elm bark beetle adults then fly to suitable dead and dying, tight-barked elm wood to lay eggs.

Most of the resultant larvae complete their development and emerge as beetles in the late summer. These beetles hibernate in short tunnels mainly in the trunks of living elm trees. The following spring the hibernating adult beetles feed further in the trunks, and then emerge in April and early May. Many fly to the limbs and branches to feed again. After feeding, the beetles fly to dead and dying elm wood to lay eggs. The resultant larvae complete their development by midsummer, emerge as beetles, feed, mate, and lay eggs. Most of these eggs produce larvae that hibernate, completing the complicated cycle.

It is the hibernating adult beetles feeding in late April and early May that transmit Dutch elm disease. In large shade elms, the secondary feeding by the beetles in limbs and branches, after emergence from hibernation, is the way most of the disease is spread. Since these beetles bred the previous summer, it is important to clean up elm-bark-beetle breeding material during the summer in order to control Dutch elm disease where the native elm bark beetle is an important carrier.

How they carry the disease

For practical purposes, both insects may be considered together in control. Either of the adult beetles picks up the Dutch-elm-disease fungus from the elm wood in which they have bred. It makes no difference whether or not the wood came from a Dutch-elm-diseased tree. The fungus is brought into dead elm wood by bark beetles entering to lay eggs. The fungus

grows well in the bark of dead elm and will do so while the insect eggs hatch and develop. When the adult insect finally emerges from the bark, it carries spores of the fungus on or in its body. In the spring, beetle adults newly emerged from their breeding places or from hiberation, proceed to feed at once on the twigs or small branches of near-by healthy elms. In so doing they introduce the fungus into the water-conducting system of the elm tree and cause infection.

It is very important to remember that the insects do not move any great distance from their place of emergence before they feed. They tend to feed within a few hundred feet of the place where they have hatched. A distance of 700 feet is about the maximum that they are likely to fly before feeding. Much use is made of this fact in the method of control advocated in this bulletin.

Recognition of the Diseased Tree

SINCE infected trees usually die, the recognition of the disease in a tree is of little importance in control. By the time symptoms appear it is usually too late to do anything about that particular tree. The principal value of recognition is to call attention to the presence of the disease in that area and to stimulate action to prevent a repetition of the tragedy. The recognition of the disease is difficult because there are at least two other diseases of lesser importance in elm, which, on the basis of external appearance, are easily mistaken for the Dutch elm disease.

A

B

FIGURE 5. ELMS SHOWING SYMPTOMS OF DUTCH ELM DISEASE

A, Extreme wilting and partial defoliation; B, wilting on young shoot

The appearance of diseased trees varies considerably according to the time of year. In June or July, elms may show wilting or shriveling of the leaves on one or more branches (figure 5, B). Holes or ragged appearance

FIGURE 6. A VERY LARGE TREE IN WHICH THE DUTCH ELM DISEASE HAS BEEN PRESENT FOR SOME YEARS

often seen in leaves are not symptoms of Dutch elm disease. Usually the progress of the disease at this time of the year is rapid and soon many branches become involved and the entire tree may die within a few weeks (figure 5, A). The wilted leaves may dry out rapidly, turn dull green, and fall from the twigs, or they may turn brown and remain for some weeks on the tree. During midsummer or later, the symptoms are usually confined to a definite part of the tree or even to a few twigs, and the leaves turn yellow then brown and fall. Trees showing these late-summer symptoms may start to leaf out in the spring and then suddenly die. Very large trees may live for several years after the first appearance of symptoms (figure 6). Few, if any, trees ever recover. In elms that are low in vigor and partially dead or dying from other causes, the disease symptoms are often obscured except perhaps on the more vigorous parts and on sucker sprouts.

Internal symptoms of Dutch elm disease appear in the outer layers of wood just underneath the bark. If the bark on a fresh green twig, branch, or trunk of a recently infected tree is peeled back, the outer layer of wood is seen to be mottled, streaked, or uniformly discolored with brown, grey, or almost black (figure 7). In a slanting cut or cross section, these discolored areas appear as stipples or as a continuous ring around the outside next to or near the bark.

None of the above symptoms, however, are a positive identification of the Dutch elm disease. Because certain other elm diseases exhibit much the same appearance, a laboratory test is needed for positive identification.

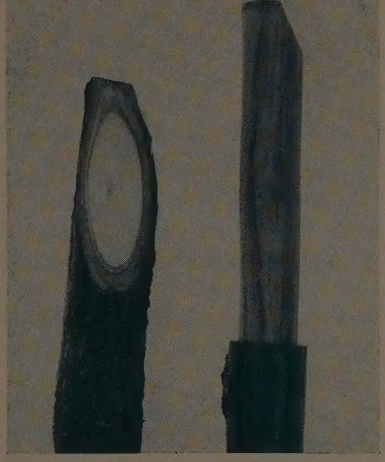

FIGURE 7. STREAKS ON TWIG

A, Longitudinal section of twig revealing discolored streaks in the wood; B, twig with portion of bark removed to show streaks on outer surface of the sapwood

For this purpose, twig samples of freshly-diseased wood are necessary. If such identification is of any advantage, the material for testing should be prepared as follows: Select several twigs, about $\frac{1}{2}$ inch in diameter and 5 or 6 inches long, from different branches recently wilted but not yet dead. Dead, dry twigs are worthless for this kind of a test. The samples selected should show the characteristic streaks or discolored areas just underneath the bark. Unless such symptoms are present, a test is not worth while. If several trees are to be sampled, it is well to disinfest with denatured alcohol the cutting tool each time it is used on a new tree. Samples should be wrapped tightly in waxed paper to prevent excessive drying, and each should be fully labeled with the location, name, and address of the collector and the date. The whole sample should then

be wrapped in heavy wrapping paper and mailed promptly to the Department of Plant Pathology at the State Agricultural Experiment Station. Do not attempt to send samples for identification if the disease is already known to be present in your locality.

Control

THE relation between elm bark beetles and the spread of the disease furnishes the key to the control methods recommended. Because the infection of elm trees is possible only if elm bark beetles have emerged from hibernation within a few hundred feet, the development of large numbers of beetles should be prevented if possible. This can best be done by destroying the breeding places of elm bark beetles before the insects have time to develop. These insects breed only in elm, and only in those parts of elm trees that are recently cut, killed, dead, or dying, and which still have tightly adhering bark. This includes recently dead or dying trees, weak branches in living trees, fallen branches or trunks, logs, woodpiles of fuel wood, and the like. Elm bark beetles are present in New York State wherever there are elms. If the Dutch elm disease fungus is also present, and it is now in practically all of the State, a certain proportion of the elm bark beetles are carrying the Dutch elm disease fungus. As the number of diseased trees in the area increases, the fungus load of the beetles increases. Therefore, the elimination or destruction of all elm wood in which elm bark beetles might develop is always the first step in the practical control of the disease.

The objective of this method is to maintain a safety zone of 700 feet radius around each tree or group of trees to be protected. Within this zone, no dead, dying, or weakened elm trees or parts of trees should be tolerated. Particular effort should be made to eliminate or destroy all potential beetle-breeding material before the first of April of each year.

To aid individuals and municipalities to deal with the problem of Dutch elm disease control, the Bureau of Plant Industry of the New York State Department of Agriculture and Markets maintains an inspection service. To the extent that personnel and funds are available, trees in towns and cities are inspected regularly. Wherever concentrations of potential elm bark beetle-breeding wood are found, the private owners or public officials are advised of the danger and urged to take action. The State cannot undertake to remove dead or dangerous trees or to dispose of other hazardous bark-beetle-breeding material. The cost of the operation must be borne by the individual or community. Often, considering the values involved, public as well as private, the destruction of bark-beetle breeding material may well be considered a community project.

In communities where this control program has been understood and followed, elm losses have been held to less than 3 or 4 trees annually per square mile. Where control has been

neglected, many elms have been killed. If neglect is continued, the cost of suppressing the disease may easily mount to a prohibitive figure. Furthermore, practically all trees that are allowed to die in residential areas must eventually be removed before they cause personal injury or property damage. It is obviously poor economy to neglect the prompt removal and disposal of dead elm wood. Removal of old dead rotten trees is more costly than removal of strong recently-killed trees.

There are several ways to destroy the wood. It may be burned or the bark may be removed and burned. It should never be kept for fuel because the insects will escape from closed rooms or cellars, open sheds, or garages. Burying the wood in soil to a depth of 1 foot or more will effectively prevent the emergence of the insects. If it is impractical or impossible to carry out any of these methods, the bark may be treated with a soaking spray consisting of a solution of 2 gallons of 25 per cent DDT concentrate in 100 gallons of No. 2 fuel oil. This spray kills all vegetation with which it comes in contact and is highly inflammable until thoroughly dry. Because of these objections and because of the difficulty in reaching the underside of large logs, this method of treating beetle-breeding wood is not recommended except as a last resort.

Dormant spraying

Dormant applications of insecticides may be used to supplement the destruction of beetle-breeding elm wood. To be safe and effective, these sprays must be applied before the leaves come out. This type of spray is designed to help protect elms from infection through beetle feeding. Such sprays may also be used where, for any reasons, the efforts to remove dangerous wood have failed. Experimental evidence indicates that prefoliar applications, properly formulated, accurately timed, and skillfully and thoroughly applied, can reduce the danger of infection. Such sprays are expensive and difficult to apply at the proper time and in an effective manner. Their use is best limited to critical situations and to particularly valuable trees. Spraying alone cannot be depended upon to adequately control the Dutch elm disease.

A large mist blower or hydraulic sprayer is required to treat adequately large elms. The mist blower is preferred. The spray is made up of 25 gallons of a xylene base 25 per cent DDT emulsifiable solution, and 25 gallons of water. From 2 to 3 gallons of this mist concentrate is applied to each large elm tree. Adequate coverage can only be obtained when there is *no* wind. Only an experienced and conscientious operator can properly apply this spray. For the hydraulic sprayer, 8 gallons of the 25 per cent DDT emulsifiable solution should be diluted in 100 gallons of water. Again heavy, complete, conscientious spraying is necessary. Properly applied, the treatment controls both elm leaf beetles and cankerworms, so no late May or June spray is required.

The DDT spray is likely to cause increased trouble from aphids and mites. Therefore, one should be on the watch and spray the trees for these pests as soon as they are evident through off color of the leaves or honey dew secretion. Tree injury may also result from several years' treatment with these heavy dosages of DDT. Because of the possible unwanted additional pest and injury-problems, as well as the high cost, spraying is not recommended as a community-wide project.

General Care of Elms

Pruning

Elms that are in good condition are less likely to develop weak and dying branches that attract elm bark beetles. Beetles entering a weak branch to lay eggs may bring with them the fungus which causes the Dutch elm disease, and the living part of the tree may thus become infected. Hence frequent and careful pruning of elms to remove all dead and weak or injured branches is a desirable practice.

Spraying for general insects and diseases

If selected elms are worth saving from the Dutch elm disease, they must also be worth protecting from other troubles which tend to weaken them and to cause branches to die. An occasional elm is found very susceptible to the black leaf spot disease. This causes the leaves to become yellow and to fall from the tree in large numbers. The affected leaves are covered with very small hard black spots. The injury may be particularly severe in seasons of drought. The result is a weakening of the whole tree. Control of the black leaf spot disease of elm may be obtained by spraying with a ferbam fungicide, 2 pounds of 76 per cent ferbam in 100 gallons of water. Two applications are suggested: the first, when young leaves are unfolding; the second, when leaves have reached full size. A third application may be desirable in very wet seasons or when the disease has been unusually destructive during the previous season. Like most fungicidal spray applications, this spray is more effective when applied shortly before a rain.

The elm leaf beetle must be controlled every year in order to maintain elms in good condition. Cankerworm outbreaks, although sporadic, can be severe enough to defoliate elms completely. These pests are easily controlled by thoroughly spraying with either 2 pounds of 50 per cent DDT wettable powder, or 3 pounds of lead arsenate, per 100 gallons of water. A sticker is used with the lead arsenate. DDT is the more effective, but may cause mites to become severe. *One who has used lead arsenate satisfactorily should not change to DDT.*

To control cankerworms, spraying should be done as soon as the leaves start to open out in early May. To control the elm leaf beetle, an annual single spray should be applied in the latter part of May or very early June.

Mist blowers may be used rather than hydraulic sprayers, as they do a much faster, cleaner, and more inex-

pensive job. With these 12 gallons of 25 per cent DDT xylene base emulsifiable concentrate may be used in 38 gallons of water at the rate of 1 quart of spray per large elm tree.

The Japanese beetle may feed heavily on elms during July and August. DDT at the same concentration as given in the preceding paragraph is effective. Several applications about 10 days apart may be required.

The elm aphid may be severe during the summer. Honey dew produced by these insects can be annoying as well as unsightly. Sooty mold grows on the honey dew, discolors painted surfaces, and gives the trees a dark cast as well. A spray of 1 pound of 25 per cent lindane wettable powder per 100 gallons of water is effective during June or early July.

Mites and scale insects may also seriously affect the appearance as well as the health of elm trees. For identification and control suggestions, one should write to the Department of Entomology at the New York State College of Agriculture at Cornell University, Ithaca, New York.

Fertilizing

The amount and composition of fertilizer needed to supplement any soil must of necessity vary with the soil composition. A conservative suggestion for fertilizing elms in closely clipped lawns or along streets is a formula approximating a 5–10–5 mixture applied at the rate of 2 pounds for each 1 inch of trunk circumference, measured at about 4 feet from the ground.

The application should be made so that the fertilizer reaches the feeding roots of the tree. These usually reach out somewhat farther than the spread of the branches. The fertilizer may be applied evenly over this area, except for the region within a few feet of the trunk. The method of application is most important to prevent burning the lawn grass.

A method frequently used is to place the fertilizer in holes about 2 feet apart over the area covering the feeding roots. Suitable holes about 15 inches deep may be made with a crowbar or some other implement. If many trees are to be fertilized, some type of power drill is a help. The total amount of fertilizer for the trees should be apportioned and distributed equally in the holes. In dry weather, water should be poured abundantly into the holes to dissolve and spread the fertilizer so that it becomes effective more quickly.

The time of application is apparently not of great importance, though the greatest benefit with least loss is probably derived from an early spring application about the time the buds are breaking or just before. A late-summer and an early-fall application might under some circumstances unduly prolongs growth in the fall.

Watering

Any condition that tends to restrict the root system of a tree or to lower the level of the ground water may cause injury by cutting down the available water supply. In the construction of sidewalks or buildings, care should

be taken not to sever or otherwise mutilate the larger tree roots. If these roots have already been cut, the damage cannot be wholly repaired. The trees can, however, be benefited in time of severe drought by supplying water to the root system that remains. Some street trees have their roots covered in large part by pavement. This may or may not be injurious, depending upon the proportion of the root system covered and upon soil conditions. In times of drought, such trees should be watched with particular care for symptoms of injury; if drought conditions become acute, water should be supplied. In grading and drainage operations, the water relations of the elm root system are likely to be upset. In grading, the roots may be left more exposed or buried less deeply in the soil than they were, with the result that in times of drought the water supply to the tree will be inadequate. Such trees should be carefully watched, particularly during the first years following grading, and water should be supplied if drought symptoms become acute. Lowering the level of the ground-water table by drainage may seriously injure or even kill elm trees, particularly those that are old, unless water is supplied for the first few years after the change takes place or until the root system becomes adjusted to the new conditions.

To be effective, watering must wet the soil to a depth of several feet. Casual surface sprinkling is of little or no value because the water does not penetrate the soil to the tree roots. On level land this presents little difficulty, as water applied to the surface soaks in effectively in most soils; but on sloping land it may be necessary to apply the water in holes, or to build small temporary dams to prevent surface runoff.

Injury from illuminating gas in the soil

Leaking gas mains sometimes cause injury to, and the death of, elm trees. The symptoms of gas injury are not strikingly different from those of severad other diseases, and the trouble is often difficult to detect with certainty. There is a yellowing of the foliage, generally weak growth, dying of the tops and terminal branches, and scaling of bark from the lower trunk. Final proof that gas is causing the trouble depends upon demonstrating the presence of gas in the near-by soil. Small quantities of gas injure trees, and gas in sufficient quantity to be detected by odor is positive evidence that near-by trees are in danger. Trees do not recover quickly from gas poisoning. A carefully planned program of feeding, pruning, and watering may save trees if the gas injury is detected before it has gone too far.

Elms for Future Planting

THE presence of the Dutch elm disease in this country raises the question whether further planting of the American elm is advisable. Where the elm is the most logical tree to use, it may still be planted if some provision is made for its protection against the Dutch Elm Disease.

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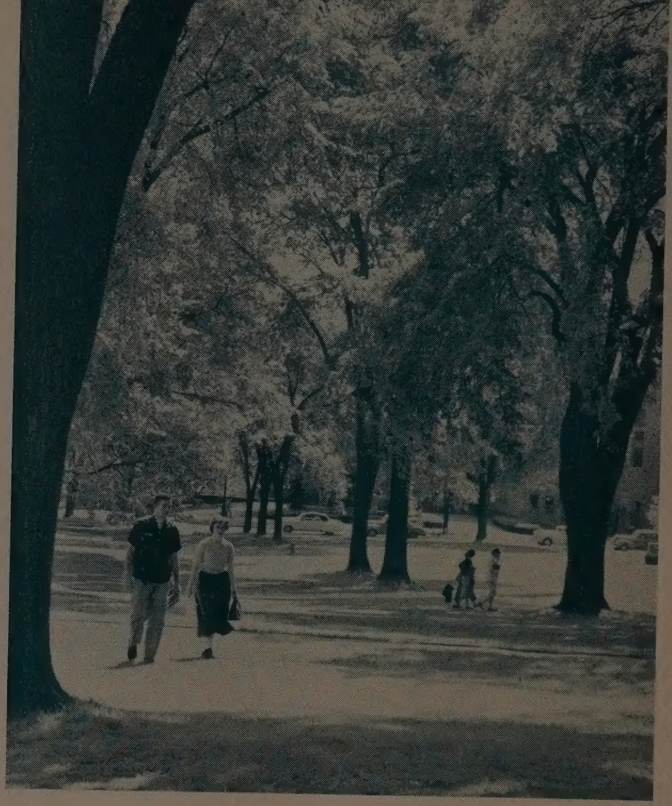

WHICH
Beauty or Beetles?
An Attractive Landscape
or a Barren Outlook?
That depends on
YOU

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